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AN ECOLOGICAL SURVEY OF THE ADDO ELEPHANT NATIONAL PARK

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(With Plates VIII and IX.)

Throughout the chequered history of the Addo National Park questions that have constantly arisen are: what do the Addo Elephants eat and is there sufficient variety of natural food available for them in the Park? It was to answer these questions that the present ecological survey was undertaken in 1950—1952.

HISTORY

The need for such a survey becomes apparent when one considers the history of the Park and the difficulty of giving sanctuary to such large and dangerous animals so close to human habitation. Elephants were frequently encountered by the earliest travellers in the coastal regions of the Eastern Cape Province and there is no doubt that this was one of their natural homes. Lieut. William Paterson (I) in the course of his journey in 1779 crossed the Sunday's River and camped at a place he calls Sand Fleet. This was probably Sandflats which is about ten miles from the eastern boundary of the Addo Park. He records that "great numbers of quadrupeds inhabit this neighbourhood, such as Lions, Panthers, Elephants, Rhinoceroses, Buffaloes, Spring Bucks, etc." Antelopes and other game of the grassy plains south of Sandflats disappeared in the face of European settlement but elephant and buffalo and other bush dwellers were able to survive, albeit in diminished numbers, in the dense bush. That they did so is largely due to the peculiar nature of the vegetation, for the Addo Bush provided not only a sufficiency of food and a tolerable amount of water, but it also formed a barricade which daunted even the most intrepid adventurer. It is made up of succulent and thorny trees and shrubs rarely more than 10 to 15 ft. high. It is without the well-defined strata of a true forest and lacks any vantage points from which compass bearings can be taken. Narrow game trails twist and turn like the paths in a maze, then peter out, and within a few minutes of leaving a clearing a casual wanderer may lose all sense of direction and easily become hopelessly lost, once out of calling distance of his companions.

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Apart from the dense bush cover, the lack of permanent streams and the climate with its intensely hot summers (maximum temperatures of 112° F.), prolonged droughts and irregular rainfall (averaging 15 inches per annum) were not conducive to the rapid expansion of agriculture. Nevertheless the clearing of bush on farms proceeded slowly and crops of wheat and maize were obtained in years of good rainfall. In 1922 the Lake Mentz Irrigation Scheme was started and brought about the development of one of the largest citrus producing areas of the Union on the irrigable land of the Sunday's River Valley adjacent to the Addo Bush.

As the human population increased and traffic on road and rail grew more frequent, the area of undisturbed bush grew less and the hazards caused by elephants to human life and their depredations among crops became matters of grave concern throughout the region. Drastic remedial measures were called for and in 1919 that famous hunter Major Pretorius was engaged by the Provincial Administration to shoot or otherwise destroy all the remaining elephants.

At this time there must have been about 126 to 150 elephants living in an area of 100 square miles (2) and the trouble they caused on surrounding farms indicates that even then they were overcrowded. By the middle of 1920 Pretorius records having shot 120 of them although other authorities put the figure at 110 (3). The arduous nature of the task and the change of public opinion in favour of preserving these unique animals brought an end to the slaughter when 16 to 30 individuals were left alive. In 1931 the Addo Elephant National Park was proclaimed, 5,268 morgen of bush covered country being set aside as a sanctuary for these animals (4) and a further portion was added in 1935 (5) bringing the total area up to about 8,000 morgen.*

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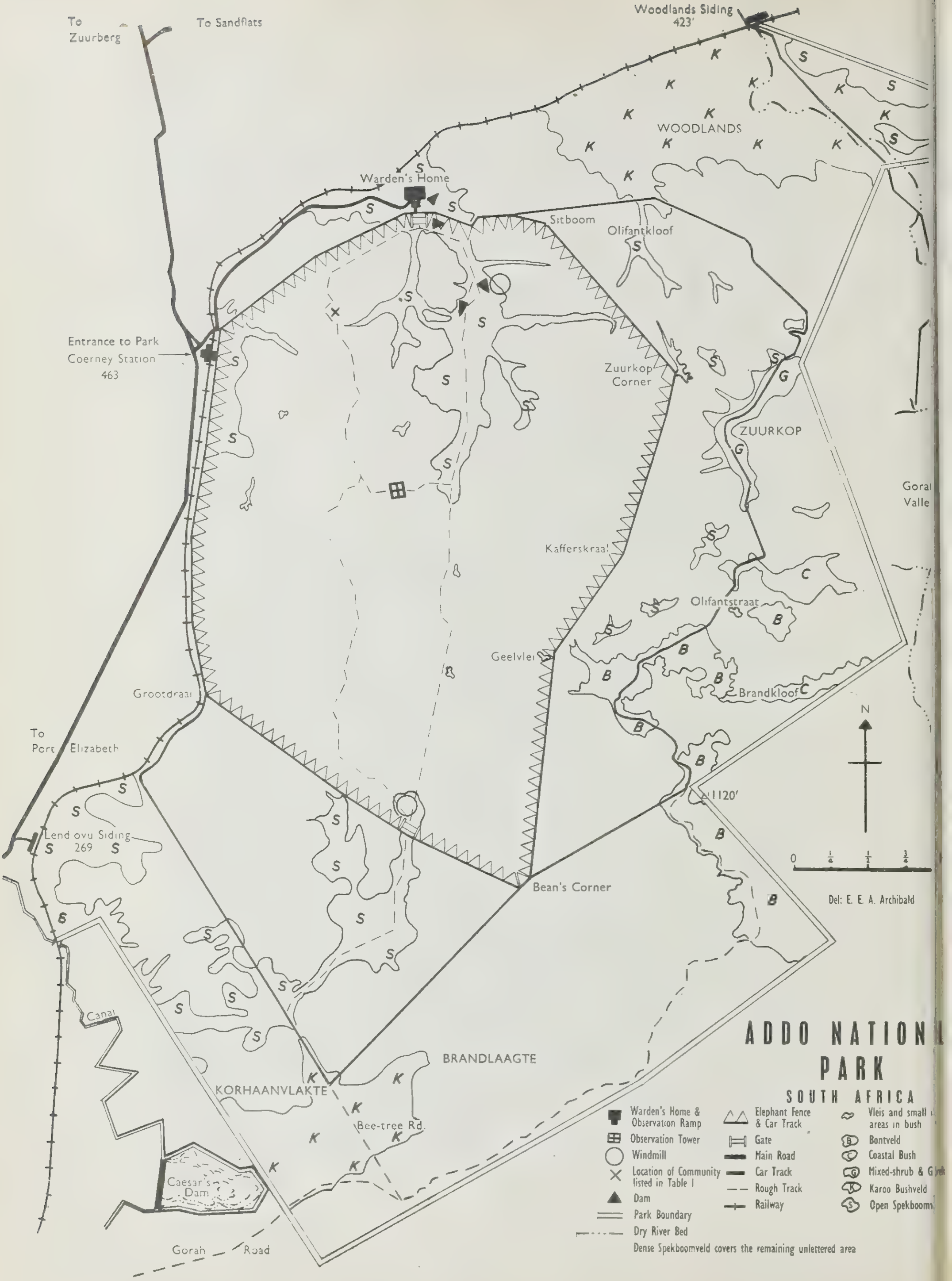
*1 morgen = 2·1 acres; 305 morgen = 1 sq. mile.

Lydekker (6) considered that the Addo Elephant, which he named *Elephas africanus capensis*, was a distinct race from the West Cape Elephant (*E. a. toxotis*, Lydekker). His main reason for separating the two was that in the former "the ears are enormous, somewhat square in shape, with rounded corners, and a small, distinct, sharply pointed angular lappet in front", and that the ears of the West Cape race were "relatively larger and not having the slightest tendency to a squared form". Recent authorities including Allen (7) and Roberts (8) consider that the evidence put forward by Lydekker is insufficient and they include both Addo (East Cape) and Knysna (West Cape) forms with the African Elephant (*Loxodonta africana africana*, Blumenbach) the type locality being nominated as the upper Orange River district (8). In view of the very different climate and vegetation in such areas as the Knysna Forest and the Addo Bush it seems desirable that a close comparison of skulls of specimens from these two localities should be made before the question of nomenclature is finally settled.

The Park is administered from Pretoria by the National Parks Board of Trustees assisted by a local Advisory Board composed of representatives from the districts of Port Elizabeth, Alexandria and Uitenhage. A Game Warden is stationed in the Park and with the assistance of African rangers its boundaries are patrolled daily since the problem of keeping the elephants from wandering is an ever present one. During the citrus season up to 1,200 lb. of oranges are daily placed in a clearing near the Warden's house. The elephants come down at dusk to partake of these and are not unduly disturbed when floodlights are switched on so that they may be seen by visitors from a protected ramp about 150 yards away. At other times of the year prickly pears and wheat on neighbouring farms cause them to break bounds and wander sometimes 10 to 15 miles from the Park.

The problem of finding a suitable fence to keep the elephants within bounds is by no means an easy one. Yet the need for such a fence is urgent since from time to time farmers have shot and fatally wounded marauders on their lands and on more than one occasion the elephants have killed Africans in the Park. For a time an electrified fence was successful but when the elephants found ways of breaking through without receiving a shock this method had to be abandoned. More recently the Warden, Mr. Graham Armstrong, has erected a fence of tram lines and lift cables. This when tested was found strong enough to resist their efforts and its success has led to a new scheme in which the elephants are to be confined to about one third of the present area of the Park. The effect of their feeding and trampling on the vegetation in this comparatively small space will be discussed below after the general physiography and plant communities have been described.


To Zuurberg
To Sandflats
Woodlands Siding 423'
WOODLANDS
Warden's Home
Sitboom
Olifantkloof
Entrance to Park
Coerney Station 463
Zuurkop Corner
ZUURKOP
Kafferskraal
Olifantstraat
Geelvlei
Brandkloof
Grootdraai
To Port Elizabeth
Lend ovu Siding 269
1120'
Bean's Corner
Canal
Caesar's Dam
BRANDLAAGTE
KORHAANVLAKTE
Bee-tree Rd.
Gorah Road
N
0
1/4
1/2
3/4
Del: E. E. A. Archibald
ADDO NATION
PARK
SOUTH AFRICA
Warden's Home & Observation Ramp
Observation Tower
Windmill
Location of Community listed in Table I
Dam
Park Boundary
Dry River Bed
Elephant Fence & Car Track
Gate
Main Road
Car Track
Rough Track
Railway
Vleis and small areas in bush
Bontveld
Coastal Bush
Mixed-shrub & G
Karoo Bushveld
Open Spekboom
Dense Spekboomveld covers the remaining unlettered area
Goral Valle

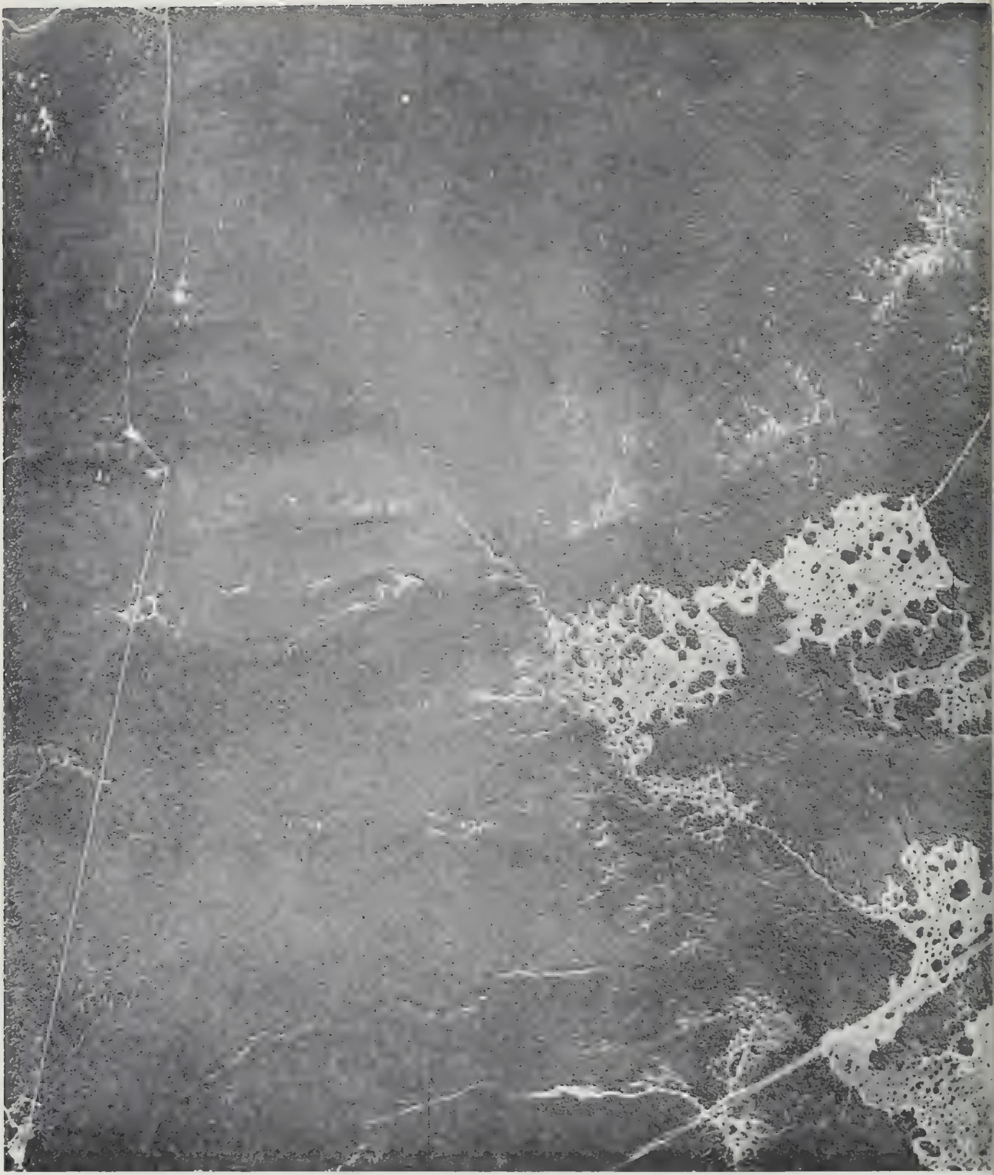


Plate VIII.

Aerial photograph of a portion of the Addo National Park showing dense growth of Spekboomveld and a small portion of bontveld (on right).

PHYSIOGRAPHY

The Park lies about 45 miles north of Port Elizabeth and covers an area of 8,000 morgen (about 17,000 acres). The highest point is on the Zuurkop escarpment (see Map), 1,120 feet above sea-level. This escarpment on the eastern boundary of the reserve is formed of limestone of the Alexandria Marine Series (Tertiary). To the west and extending over the greater portion of the reserve are undulating hills with an average altitude of 450 feet. They are covered by a light-red clay loam overlying Uitenhage Marine Beds (Cretaceous). On the northern side drainage is towards the Coerney River and on the southern side shallow valleys drain in a south-westerly direction into Caesar's Dam, a small reservoir on the irrigation canal.

Several small natural vleis occur in various parts but these are dry during the greater part of the year and the only permanent water supply in the reserve is from two boreholes, one of which is brack.

VEGETATION

The vegetation of the Sunday's River Valley and its immediate surroundings is classed by Pole Evans (9) and Acocks (10) as part of the Karoo Region, a semi-arid region in which, as Cannon (11) has shown, many plants have succulent leaves and stems or show other structural modifications related to the xerophytic habitat. The Addo National Park is situated in the most southerly section of this region and I know of no other locality where succulent, thorny bush attains such a dense and vigorous growth. Locally it is known as the Addo Bush, a name that might well be used to distinguish it from the Fish River Scrub in which species of Euphorbia such as *E. coerulescens* Haw. and its varieties are common.

From field surveys it was found that there are five main plant communities in the park. The area covered by each of these has been estimated and mapped from aerial photographs (Plate VIII). The most extensive plant community can be conveniently referred to as Spekboomveld since in it Spekboom (*Portulacaria afra*) is dominant. It covers more than 90 per cent. of the total area and it is one of the main sources of food for the elephants. The four minor communities will be described briefly first.

1. **Karoo-bushveld.**

This occurs on (*a*) Korhaanvlakte in the south-west corner of the reserve where the ground is flat but inclined slightly towards Caesar's Dam; (*b*) the north-east sector known as Woodlands. It covers about 7 per cent. of the total area and is an open community composed of low karroid shrubs not more than about 12 inches high. They occur singly or in groups with areas of bare ground up to about 9 sq. ft. between the units. The most frequent species are *Pentzia globosa* Less. (Goedkaroo), *Justicia orchioides* L. f., *Lampranthus productus var. lepidus* Schwantes and two species of *Ruschia* (vygies), but even these are sparsely distributed and on Korhaanvlakte would not be found constantly on areas less than 16 sq. metres. With November rains the annual, *Sutera campanulata* O. Ktze. becomes abundant between the karoo bushes. In parts a white efflorescence of salt can be observed on the soil surface and locally this type of veld is known as brackveld.

2. Mixed Shrub and Grassveld.

This mixed community of small shrubs and grasses forms only about 0·4 per cent. of the vegetation and is restricted to the limestone plateau on the eastern boundary of the Park known as Zuurkop. The soil over the limestone varies in depth, in some parts being as shallow as two inches. It is a dark yellowish-brown or greyish-brown sandy loam with a pH of 8·3. In spite of the comparatively high alkalinity of the soil the vegetation is known locally as zuurveld owing to the unpalatability of certain grasses to stock. It is an open community of small shrubs with ericoid leaves and grasses, and contains far fewer succulents and geophytes than the Karoo-bushveld community. Cover is sparse and no one species can be considered abundant, the most frequent occurring constantly only on areas larger than 16 sq. metres. Among the more common shrubs are *Polygala ericaefolia* DC., *Nenax microphylla* Sond., *Anthospermum cilare* L., *Agathosma capensis* Dummer. and *Walafrida decipiens* Rolfe. The grasses are best represented by *Eragrostis brizoides* Nees and *Sporobolus capensis* Kunth.

3. Bontveld.

The term bontveld is used here to describe a type of vegetation that is very characteristic of the coastal districts of the Eastern Cape Province. It consists of circular clumps of bushes up to 15 feet high and 30 feet in diameter dispersed in grassland or a mixed grass and low shrub community. The word "bontveld" (mottled ground) was used by the early Dutch settlers and is in common use amongst farmers in the Eastern Cape to-day. Speculation as to the cause and permanence of the bush clumps in bontveld would be out of place here, it being sufficient to note the extent of it in the Park and some of the most frequent species that characterize it.

Bontveld covers 3 to 4 per cent. of the area of the Park occurring chiefly on the Zuurkop plateau where a slight tilt gives the area the benefit of a southern aspect. It is convenient in describing this type of vegetation to split it up into the bush clump community and the surrounding community.

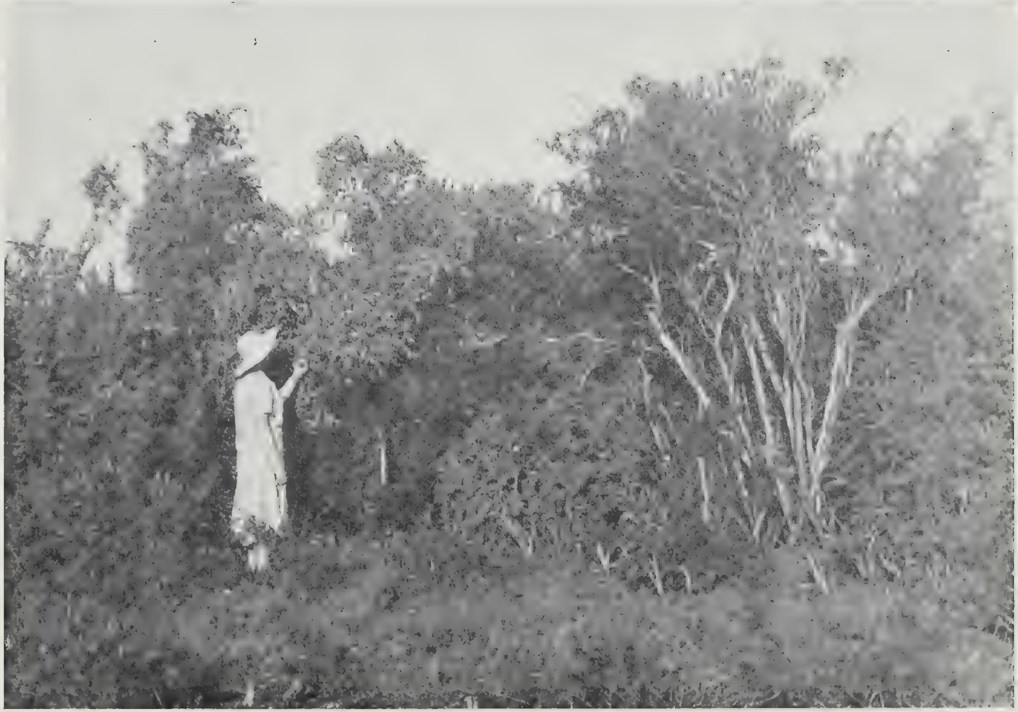


PLATE IX.

Addo Bush. Margin of bulldozed track showing dense growth of typical spekboom community, *Sansevieria* in undergrowth, *Portulacaria* and *Euclea* against sky line.

(*a*) *Bush Clump.* The area covered by each clump is comparatively small and although some plants appear to be more conspicuous, being larger or more profusely branched, it would hardly be correct to speak of any one species being dominant, since only a few individuals of each occur in a clump. However, comparing one clump with another, if they are well-developed and not obviously in the pioneer stage, one finds that some species are always represented in each clump whereas others are of only sporadic occurrence. Species of constant occurrence on the limestone plateau are *Scutia myrtina* Kurz., *Grewia occidentalis* Th., *Royena pallens* Th., *Gymnosporia buxifolia* Szyszy and *Rhus incisa var. obovata* Schonl. On the red loam of the Uitenhage series in the north-west corner of the reserve *Rhus longispina* E. & Z. and *Ehretia rigida* Druce are always likely to be present.

(*b*) *Surrounding Community.* On the northern boundary of the Park where *Rhus longispina* is conspicuous in the bush clumps, the chief constituents of the surrounding community are small karroid shrubs. One of the commonest is *Pteronia incana* Less.

However, on the limestone plateau, bontveld is characterized by the predominance of grasses in the surrounding community. No one species is really dominant but a number can be classed as frequent in contrast to the remaining species. They are *Themeda triandra* Forsk., *Panicum deustum* Nees, *Panicum maximum* Jacq., *Digitaria eriantha* Steud., *Elusine indica* Gaertn., *Eragrostis brizoides* Nees, *Eustachys paspaloides* Lanza and Matti, *Heteropogon contortus* Beauv. and *Cynodon dactylon* Pers. Two shrub species that are locally abundant are *Chascanum dehiscens* Moldenke and *Pelargonium multicaule* Jacq.

4. **Coastal Bush.**

Typical stands of Eastern Cape Coastal Bush occur in the south-west corner of the reserve in a kloof known as Brandkloof, and on the fringes of the Zuurkop plateau. Characteristic tree species are *Sideroxylon inerme* L. (Milkwood), *Schotia speciosa* Jacq. (Boerboon) and *Pterocelastrus tricuspidatus* Sond. (Kershout). The area is not extensive, forming only 1 per cent. of the total area of the reserve.

5. **Spekboomveld** (*Portulacaretum*).

This type of vegetation (Plate IX) covers the greater portion of the Park. The dominant species is *Portulacaria afra* Jacq. (Spekboom), which is also one of the main items of elephant diet. In the vegetation map open spekboomveld has been shown separately from dense spekboomveld. The open community has clumps of spekboom and other tree species interspersed with small succulent and karroid shrubs. It forms about 23 per cent of the total area, and occurs mainly in shallow valleys, around vleis and waterholes and on the margins of other communities. At the present time there is not sufficient evidence to state whether it is a natural marginal community or whether it has been artificially created as the result of grazing.

In dense spekboomveld karroid shrubs are absent and the bush and tree cover is thickly matted from three to fifteen feet above ground level. A careful survey of a typical portion of this community was made with a view to determining the frequency of occurrence of the main food species. For this purpose the Multiple Quadrat Method was used (13). As there was no continuous carpet of small herbs or other plants underneath the bush, the smaller sizes of quadrat were dispensed with and only three large sizes were used, namely 1, 16 and 64 sq. metres. Because of the tangled thorny nature of the bush the area of observation was limited to about 4 acres on either side of a bull-dozed track in a region where traces of elephant feeding were frequent. With the assistance of Mr. Graham Armstrong, and his African rangers, the sample areas or quadrats were laid out by means of a measured rope. The presence of each species within each quadrat was then recorded and the results are given in Table 1.

TABLE 1.

ANALYSIS OF SPEKBOOM COMMUNITY (PORTULACARETUM) IN THE ADDO NATIONAL PARK. NOVEMBER, 1950.

Species.	Frequency of Occurrence of Species in a Total of 20 Quadrats. Quadrat Size in Square Metres.		
	1	16	64
Portulacaria afra	*15	20	20
Sansevieria thyrsiflora	*10	20	20
Azima tetracantha	10	19	20
Asparagus sp.	3	18	20
Capparis citrifolia	* 2	17	20
Rhoicissus spp.	* 5	15	20
Euclea undulata	* 4	15	20
Panicum spp.	* 5	13	20
Schotia speciosa	* 3	17	19
Asparagus subulatus	1	10	18
Crassula expansa	2	4	18
Rhus longispina	3	14	17
Sarcostemma viminale	2	9	16
Crassula perforata	—	4	16
Pelargonium peltatum	—	3	15
Crassula cultrata	—	8	14
Cadaba juncea	2	7	13
Gymnosporia spp.	* 5	10	12
Cineraria lobulata	2	5	12
Viscum rotundifolium	1	9	10
Carissa bispinosa	—	5	10

Species.	Frequency of Occurrence of Species in a Total of 20 Quadrats. Quadrat Size in Square Metres.		
	1	16	64
Maerua triphylla	—	5	9
Bulbine sp.	—	1	9
Commelina benghalensis	1	5	8
Cryophytum angulare	—	4	8
Asparagus africana	*—	3	8
Putterlickia pyracantha	?—	2	8
Poa sp.	3	5	7
Asparagus striatus	* 2	3	7
Rhus sp.	3	3	7
Behnia reticulata	2	2	7
Aizoon glinoides	2	4	6
Asparagus kraussii	—	2	6
Cyphia heterophylla	—	2	6
Plumbago capensis	—	2	6
Scilla sp.	—	1	6
Cynodon dactylon	* 1	3	5
Stipa dregeana	—	1	5
Crassula lycopodioides	—	—	5
Aster sp.	—	4	4
Commelina africana	1	3	4
Pteroxylon obliquum	1	3	4
Crassula turrita		1	4
Chenopodium sp.	1	2	3
Crassula rosularis		1	3
Cynanchum sarcostemmatoides		1	3
Delosperma No. 35	—	1	3
Abutilon sonneratianum	—	—	3
Delosperma No. 70	1	2	2
Atriplex sp.	—	2	2
Jasminum angulare	—	2	2
Delosperma No. 53	1	1	2
Aloe africana	*—	1	2
Euphorbia burmanni	—	1	2
Fockea edulis	—	1	2
Galenia pubescens	—	1	2
Grewia occidentalis	—	—	2
Solanum quadrangulare	—	—	2
Crassula spathulata	1	1	1
Asparagus sp.	—	1	1
Crassula argentea	*—	1	1
Gymnosporia capitata	—	1	1
Ceropegia carnosa	—	—	1
Euclea sp.	—	—	1
Eragrostis brizoides	—	—	1
Ipomea ficifolia	—	—	1
Oxalis sp.	—		1
Senecio sp.	—	—	1
Average number of species per quadrat	4·6	16·05	26·7
Total number of species in area sampled			71

*Indicates species eaten by elephants.

DISCUSSION

The smallest size of quadrat on which a species is found to be present constantly is a useful indication of the density of growth. For example in a grass sward where there is continuous cover the most frequent species has been found to be present constantly in an area of 25 sq. cms. (13). The size of the plant has of course to be taken into account, as far fewer individuals of a tree species can grow on a square metre of soil than individuals of a grass species. Consequently it is to be expected that the constant area of a tree species at maximum density will be greater than that of any herbaceous species at maximum density. It has already been stressed that in the Addo Bush *Portulacaria afra* (Spekboom) attains an exceptionally vigorous and dense growth and Table 1 shows that it was constantly present in sample areas of 16 sq. metres but only found in 75 per cent. of the sample areas of 1 sq. metre.

If left undisturbed *Portulacaria* grows into a much branched tree with a maximum height of 15 ft. and a trunk up to 9 ins. in diameter, the crown having a spread of about 10 ft. Such trees only exist where they are well protected by other vegetation as there is very little woody tissue in their stems and they are easily broken. The plants coppice freely and the usual form of propagation is from fallen stems, which retain their vitality for some time if conditions are not favourable for root production. Dense clusters of individuals 4 to 6 ft. tall are of frequent occurrence and because of this variable habit of growth it is very difficult to estimate the number of individuals per unit area.

The only other species with an area of constant presence equal to that of *Portulacaria* was a plant of the undergrowth, *Sansevieria thyrsiflora* (Bushman's Hemp), a member of the Liliaceae with rhizomes up to an inch thick and about 3 ft. long. The most frequent shrubby species was *Azima tetracantha*, a very thorny straggling plant belonging to the Salvadoraceae and having in this region a constant area of more than 16 sq. metres.

Within the area sampled a total of 71 species was found and an idea of their very scattered distribution may be obtained if we consider the "pattern unit" of the community. This pattern unit has been defined as the smallest area upon which an average of half the total species in the community can be expected to occur (14). For herbaceous communities, it has been shown (14) that the pattern unit where the cover is dense varies between 0·01 sq. metres and 1 sq. metre, and when cover is sparse and the component species very scattered, it may be as much as 1,000 sq. metres. For the *Portulacaretum* it would appear from a rough estimate that the pattern unit is of the order of 300 sq. metres.

ELEPHANTS AND THEIR FOOD

1. **Plants Eaten.**

Information about the natural food of the Addo Elephants has been obtained in two ways, firstly by observing their spoor and examining the plants after they have been feeding in a certain locality and secondly by an analysis of dry faeces. A list of these plants is given in Table II. Many of them occur in the Spekboom community where their frequency of distribution may be judged from Table I. Individual species that contribute most to elephant diet are *Portulacaria afra* and *Sansevieria thyrsiflora*, occurring in the Spekboomveld; *Schotia speciosa* and *Gymnosporia spp.* in Spekboomveld, bontveld and coastal bush communities; and several species of grasses, including *Cynodon dactylon*, *Panicum deustium* and *Panicum maximum*, which are to be found in bontveld, although these two also occur sporadically wherever there is an opening or clearing in spekboomveld. *Euclea undulata* was also reported by the former warden, Mr. Johnson, (*fide* Dr. John Hewitt), to be an important item of elephant diet.

TABLE 2.

PLANTS EATEN BY ADDO ELEPHANTS.

Species.	Common Name.	Part Eaten.	Evidence Field.	From Faeces.
Acacia karoo	Mimosa, Doringboom	Bark of young shoots	†	
Capparis citrifolia	Wag-'n-bietjie	Roots	†	
Crassula argentea	t'Kerkai	Leaves and stems	*	
Euclea undulata	Gwarrie	Leaves, young shoots	*	*
Gymnosporia undulata	Pendoring	Roots chiefly, also shoots	**	**
Gymnosporia polyacantha	Pendoring	Roots chiefly, also shoots	**	**
Lebeckia cuspidosa	—	Bark of young shoots	†	—
Portulacaria afra	Spekboom	Leaves, stems	**	**
Putterlickia pyracantha	Pendoring	(Roots?)	?	?
Rhoicissus digitata	—	Leaves, stems	—	*
Schotia speciosa	Boerboon	Leaves	**	**
Aloe africana	Aloe, alwyn	Stem	†	—
Asparagus africana	Katdoring	Leaves, stems, (roots?)	?	*
Asparagus striatus	—	Leaves, stems	—	*
Cynodon dactylon	Kweekgras	Leaves, culms	**	*
Panicum maximum	Buffelsgras	Leaves, culms	—	**
Gramineae (at least 2 other species)	Grasses	Leaves, culms	—	**
Sansevieria thyrsiflora	Bushman's Hemp	Rhizomes	**	**

Species.	Common Name.	Part Eaten.	Evidence Field.	From Faeces.
Exotics·				
Citrus	Orange ..	Fruit	**	**
Opuntia	Prickly pear ..	Fruit and young shoots	†	—
Ananas	Pineapple ..	Fruit	†	—
Triticum	Wheat	Leaves, grain	†	—

**Major food species.
†On authority of the Warden, Mr. Graham Armstrong.

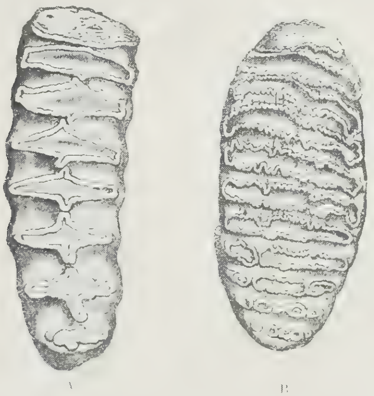
The bark of young shoots of *Acacia karoo* and *Lebeckia cuspidosia* is also eaten by elephants. These species occur in very limited areas of two or three acres, the former just below the observation ramp and occasionally in zuurveld, and the latter as a subsidiary shrub in the grass of bontveld. Other food species occur mainly in spekboomveld but are also to be found in bontveld, coastal bush and zuurveld.

2. **Feeding Habits.**

Elephants obtain roots and rhizomes by swinging a forefoot to and fro and so kicking away the soil. Large thorny bushes of pendoring (*Putterlickia* and *Gymnosporia spp.*) are entirely uprooted in this way and much of the surrounding vegetation is also destroyed in the process. According to Selous (15) the tusks are also used in prising out roots. The food is grasped and brought to the mouth by the prehensile tips of the trunk. The African Elephant has two finger-like tips to the trunk instead of one as in the Indian Elephant. The delicacy of touch and manoeuvreability of these tips can be judged from the fact that they can strip the fine layer of bark off the young shoots of *Acacia* and *Lebeckia*, in both of which the growing points are protected by a barricade of sharp spines. With other plants whole branches are broken off and are pulled through the mouth by the trunk, as leaves and bark are being chewed off. With such succulent soft stemmed plants as spekboom, all the leaf and stem tissue is masticated and swallowed.

The dentition of elephants is very remarkable. According to Owen (16) the total number of teeth developed are $i = \frac{2+2}{0+0}$, $m = \frac{6+6}{6+6}$. Of the incisors (i) the first pair form two small milk-tusks which are deciduous; they are followed by the secondary incisors which continue to grow during the life-time of the animal, forming the tusks. In the female the tusks are less well developed than in the male.

Of the molars (m) only one, or a part each of two, on each side of both jaws, is in place and in use at any given time. Owen states that "the first molars are in place and in full use at three months and are shed when the elephant is two years old". The subsequent molars grow forward in turn, perform their grinding functions for a period, wear away and are finally lost as new ones take their place. Each molar is like a massive compound tooth having a number of vertical plates of dentine each surrounded by a layer of enamel, the spaces between being filled with cement which binds the plates together and covers the whole tooth. As the tooth comes into use the cement crown is worn away and the enamel ridges, also wearing away, form an excellent grinding surface for the animal's vegetable diet. The pattern of the enamel ridges as exposed on the grinding surface is a further distinguishing character between the African and Asiatic elephants (Fig. 1.).



(*British Museum Guide Book.*)

FIG. 1.

A. Dentine pattern of molar tooth of African Elephant.
B. Dentine pattern of molar tooth of Asiatic Elephant.

With these massive teeth, elephants are capable of breaking up thick, tough woody stems and roots as well as soft leaf and fruit tissue. In the further processes of digestion all nutritive material is removed and in the droppings only the skeleton of roughage remains, including pieces of woody and fibrous plant tissue up to 5 inches long, fragments of bark and short pieces of stem still showing the structure of thorns. Seeds and bits of fruit are also found and, most useful of all for purposes of identification, portions of dried leaves which, being eaten with surrounding fresh leaves, have passed through the tract practically unchanged. Spekboom material is easily distinguished from other plant material because of the fine network of fibrous tissue which is associated with the vascular system and which does not lose its character in the process of digestion.

The faeces are large and when air-dry weigh anything from 150 to 240 gms. The dry material can be separated into coarse fibrous remains of spekboom, coarse woody remains chiefly of pendoring, leaf tissue, and fine material. Since the recognisable leaf tissue only forms an insignificant portion of the total weight it has been omitted from Table III where analyses of faeces collected in the spekboom community and the bontveld with grass community are compared.

TABLE 3.
ANALYSES OF FAECES.

Sample No.	Community.	Coarse Portulacaria Fibre %	Coarse Woody Material %	Fine Material %	Total Weight per Ball (gms.)
1	Spekboomveld . .	14	41	45	164
5	Spekboomveld . .	37	14	49	235
8	Bontveld with grass	0·7	2·8	96·5	176
9	Bontveld with grass	0·6	—	99·4	171

Apart from the very different amounts of coarse material (woody and spekboom) present in droppings collected from different communities, a further difference in the diet of animals browsing in these communities is shown by the nature of the fine material. In spekboomveld it is estimated that at least half the fine material consists of finely shredded spekboom fibre while a large proportion of the remainder consists of small woody fragments. The fine material from the bontveld community has a much softer texture owing to the presence of a large quantity of short flattened pieces of the stems and leaves of at least three species of grass. This fine material is difficult to separate but it is estimated that about 50—75 per cent of it is grass, the remainder consisting of small woody fragments, fine *Sansevieria* fibre and a little spekboom fibre. Livingstone (15) and Heller (15) record having seen elephants eat grass but Selous (15) remarked that they "very rarely, I believe, eat any kind of grass". The evidence from faeces certainly indicates that at times grass forms an important item in the diet of Addo Elephants.

3. **Quantity of Food Required.**

In conclusion it seems necessary to try and make some estimate of the amount of food required by the Addo Elephants in order that the information should be available for guidance in formulating future conservation policy for the Park. Since it is impossible to observe directly how much a wild elephant eats an estimate has been made in the following way.

Supposing spekboom to be one of the staple items of diet, on an average of samples 1 and 5 (Table III) 200 gms. of faeces contain about 50 gms. of coarse spekboom fibre and also about 50 gms of fine, i.e. 100 gms. in all. It was found that spekboom shoots of the size most favoured by the elephants were about five years old. They were 50 to 60 cms. long, weighed about 200 gms each and investigation showed that they would yield 10 per cent of air-dried fibre. Hence as a rough estimate the 100 gms. of fibre represent a total weight of 1 kgm. of fresh spekboom eaten for each ball of faeces passed. According to Benedict (17) a captive elephant showed an average of 16 defaecations of 5 balls each per day. Hence an Addo Elephant would require 80 kgms. (176 lbs.) of spekboom per day, or the equivalent of 400 five-year-old shoots. The remaining 100 gms. of coarse woody material and fine material in each ball comes from plants which are much less digestible than spekboom. It is estimated that as much as 20 per cent of the weight eaten will appear in the faeces. Hence this corresponds to a further 40 kgms. of plant material. The total food requirement of an elephant is thus estimated to be 120 kgm. (264 lbs.) per day.

It is of interest to compare this approximation with the amount eaten by the African Elephant at the National Zoological Gardens, Pretoria. The daily ration of this animal is:—

	Lbs.		*Lbs.*
Green lucerne	30	Dry grass	40
Dry lucerne	35	Oathay	20
Bran	6	Bread	4
Thick, yellow maize porridge	4	¼ lb. hops, a little treacle and occasionally pumpkins and kikuyu grass.	

This gives a total of 140 lbs. a day, but since 109 lbs. is dried or prepared food, the corresponding fresh weight is likely to be at least 250 lbs. According to Benedict (17) a herd of 18 female circus elephants (the Barnes herd) received during their working season about 170 lbs. each per day, part of which was dried food. It may be noted that the average weight of a circus elephant is 6,000 lbs. and it requires 50 gallons of water a day.

In judging these figures it must be borne in mind that captive elephants are fed largely on dried or prepared food and that they lead a very sedentary existence as compared with wild animals. Under natural conditions a considerable amount of energy would be expended on browsing, in play and in long tramps when changing territory. In the 8,000 morgen of Addo Park territory there are now 18 elephants, consisting of 2 bulls, 9 cows and 7 calves, one of which is two months old (*fide* G. Armstrong, 9/6/52). They are restless animals and although they remain in an area of about 2,500 morgen for several days at a time they are constantly on the move. They feed at all times of the day but more particularly at dusk and during the hours of darkness. Some members of the herd may travel 15 to 20 miles at night across the boundaries of the Park and back again, returning to the vicinity of the herd to spend the daylight hours in browsing and resting. After a time the whole herd moves its daylight quarters to another section of the Park. Thus their feeding is at present spread over the whole area of the Park and not infrequently beyond its boundaries. With all this expenditure of energy, the estimate of 264 lbs. fresh weight per day as the normal food consumption of an adult animal cannot be considered excessive.

It is very difficult to make any reliable estimate of the grazing capacity of the Park in relation to the food requirements of the elephants. A working figure of 1 sq. mile per beast has been recommended (18); this figure was deduced as follows.

It has been suggested that an elephant eats the equivalent of 400 five-year-old shoots of spekboom a day. This vegetation would only be replaced after six years, i.e. about 2,100 days. During this time the animal must eat 840,000 shoots from other trees. Observation suggests that elephants destroy at least $1\frac{1}{2}$ times as much vegetation as they eat, so that 2,100,000 shoots should be available per six-year growth cycle. From the figures for the occurrence of spekboom in Table I it may be shown that, assuming a random distribution, there will be about 1 spekboom per square metre. Such a plant would have the equivalent of about 10 five-year-old shoots. Hence the elephant would require 210,000 such plants per six-year cycle, and these grow on 210,000 sq. metres, or 25 morgen. Spekboom develops into a well-grown tree in about 24 years, i.e., 4 cycles, and therefore to maintain the bush in a condition congenial to the elephants, with spekboom as the dominant species (Table I), at least 4 cycles must be allowed for regeneration. This leads to the figure of 100 morgen per animal.

There are various factors impossible to estimate at present, such as the proportion of other plants in the diet of the elephants and their need for a change of diet, e.g. from spekboom to grass, which probably accounts for their periodic changes of feeding ground. To allow for these it has been thought advisable to multiply the estimate made on the basis of spekboom by three, giving the round figure of 1 square mile per elephant.

At present the only conspicuous signs of deterioration of vegetation in the Park are to be seen around the bore holes, where constant rubbing and trampling prevent even the spekboom from regenerating. However, part of this trampling is due to other animals frequenting the bore holes, especially buffalo, whose numbers in the Park have been variously estimated as between 180 and 400. For the purpose of this survey the presence of other animals has not been taken into account but they must also be considered as important factors when planning any future conservation policy. Kudu, Bushbuck, Grysbok, Steenbok and Duiker live in the Park; other animals include Jackals, Genets, Mungooses, Ratels, Polecats, Porcupines, Hares, Wild Pigs, Aardvarks (Antbears) and Vervet Monkeys.

In concluding this survey I strongly recommend that the enclosure of the elephants in any section of the Park should be regarded only as a temporary measure to prevent further annoyance to farmers and also indiscriminate shooting of the elephants. The reasons for this recommendation are that not only does an area of 2,000 to 3,000 morgen of spekboomveld contain insufficient food to support the Addo herd indefinitely, but that the animals require a change of diet and should not be confined to any one type of plant community. The ultimate objects should be (1) to add judiciously to the area of the Park by including such types of plant communities as are not well represented within its present boundaries and which provide useful sources of food for the elephants and other animals, and (2) to erect an elephant-proof fence around the entire reserve.

Note: The elephant-proof fence enclosing about 3,000 morgen and erected by the Warden, Mr. G. Armstrong, was completed early in 1954. The herd confined in this area now consists of 2 bulls, 8 cows (1 having presumably died during 1954) and 10 calves (2 born in 1953 and 1 in 1954).

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